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Method of Producing a Porous, Plate-Shaped Metallic Composite

The invention relates to a method of producing a porous, plate-shaped metallic composite. Also the subject matter of the invention is a sound-absorbing panel.

The production of porous, plate-shaped metallic composites, which can be used, for example, as light construction elements or sound dampening panels, are known from the state of the art.

For example, DE 39 35 120 discloses a method of producing metallic composite panels, according to which two outer, non-perforated metallic panels having a bridging material in the form of a metal grating of wire disposed between them are interconnected. The special feature of this method is that the grating intersections of the metallic grating, prior to a connection of the metallic grating with the metallic panels, are first rolled flat by means of a rolling process to the thickness of a wire, so that thereafter the grating intersections of the metallic grating can be welded or glued with the metallic panels. Advantageously obtained in this manner is a metallic composite panel that can still be further processed by a subsequent forming process.

A further method of producing metallic composite panels is known from DE 20 57 474. Disclosed are porous metallic fiber panels as well as a method of producing the same. The method described here is characterized by the use of a fiber fleece that at a temperature between 100° and 150°C is pressed in locally determined regions with a pressure of 700 N/cm^2 to 1200 N/cm^2, whereby only in these predetermined regions is a sintering of the fibers also effected. There thus results a metallic fiber panel that is sintered only in certain regions, and that has an adequately great strength, yet also has regions with a relatively large fiber surface.

Additionally known from DE 199 24 675 is a sintering metallurgical method for producing a filter body of smelt extracted metallic fibers. This method is used, for example, for producing a porous body, especially a filter body of fibers, in particular metallic fibers. In this connection, it is provided that the loose fibers, which are present as bulk material, are separated by agitation, are filled into a mold, and a charge is subsequently heated to sinter it. As a result of the sintering, there results a solid and stable porous body that can be used, for example, as a filter body. In addition to the previously described possibility of use as a filter body, it is also known to use sintered

metallic fiber materials in the area of sound dampening. Thus, the use of such sintered metallic fiber materials has proven itself, for example, for reducing noise emission in gas turbines.

With all of the aforementioned methods, the sintering step is typically effected at a temperature that is between the liquid temperature and the solid temperature of the material that is used. The fiber length and the fiber diameter of the fibers that are to be interconnected by sintering can vary greatly, whereby the fiber diameter can be in the range of 1μm to 250 μm and the fiber length can be in the range of between 50 μm to 50 mm.

To prevent a premature oxidation of the fibers, the sintering process is carried out in a vacuum oven. In this connection, the actual sintering times are in the range of many hours, whereby the material that is to be sintered is provided into the sintering process in a mechanically compacted or initially pressed state. The sintered bodies produced in this manner are cut to size after the process has been carried out, and can then be used, for example, as acoustical dampening material, and can be placed, for example, in exhaust gas mufflers of gas turbines.

However, the known methods have the drawback that due to the size of the sintering ovens that are available, it is possible to produce only such sintered bodies that are limited in their geometrical configuration in correspondence to the size of the oven used. If, for example, sintered bodies of the aforementioned type are produced that at least in their length exceed a size of, for example, 1500 mm, this is not possible using the aforementioned method. In order nevertheless to be able to produce such sintered bodies, it is necessary to first produce relatively small sintered bodies in a first method step that are then appropriately interconnected in a second method step, for example being glued or welded together. The drawback of carrying out such a method is that it is not only time consuming but also expensive.

It is therefore an object of the invention, while avoiding the aforementioned drawbacks, to provide a method with which while simultaneously reducing manufacturing costs, it is possible to produce a plate-shaped metallic composite of fibers of any desired size, at least with regard to one dimension, that can be sintered. The invention should also propose a sound-dampening panel.

To realize this object, the invention proposes a method of producing a porous, plate-shaped composite according to which metallic fibers are pressed and welded or fused together in a single step.

In contrast to the methods known from the state of the art, there consequently inventively results a material-flow connection of the individual metallic fibers, not by sintering but rather via fusion. This is not only relatively economical, but also opens the possibility of being able to form a metallic composite of any desired length, at least in one dimension.

For carrying out the inventive method, metallic fibers are introduced into a welding or fusing device provided therefor. The metallic fibers are preferably processed in the form of prefabricated metallic fiber mats that are wound off from a roll, for example as quasi endless mats. Alternatively, it is also possible, where the metallic fibers are present as bulk material, to possibly first separate them in a first step and subsequently to supply them as loose metallic fiber material to the fusing device. The introduction into the fusing device can be effected continuously, so that in the further carrying out of the method, metallic composite panels having an unlimited length dimension can be produced. The fibers introduced into the fusing device are then

compacted and fused together in a single step, for which purpose laminar electrodes are advantageously disposed on both sides of the metallic composite that is to be formed, with the electrodes serving on the one hand for fusing the individual metallic fibers, and on the other hand also serving for the application of an adequate pressure.

The fusing process is advantageously the pulse fusing process, preferably the capacitator pulse fusing process, whereby the electrodes that are used have a laminar area of preferably between 10 mm^2 and 25,000 mm^2. A particular characteristic of the capacitor pulse fusing process is the relatively short duration of the actual fusing process, which is generally less than 1s; in conjunction with carrying out the inventive method, it can even be less than 10 ms.

Due to the very short and very high current pulse of up to 200,000 A, there is formed from fiber to fiber of the compressed-together metallic composite an electrical resistance that leads to heating of the material at that location and a point-type fusing with the closest fiber. The specific welding or fusing energy that is applied is in this connection 0.2 J/mm^2 to 7.5 J/mm^2.

Prior to and/or during the fusing process, the metallic fibers of the metallic composite are subjected to a pressure, whereby the pressure is preferably produced with a pressing force of 0.1 N/mm^2 to 10 N/mm^2, preferably from 1.5 N/mm^2 to 6 N/mm^2 .

The advantage of the inventive method is further that the metallic composite, which is composed on a basis of individual metallic fibers, due to the electrical charge that acts in a shock-type manner, additionally has its structure compacted. As a result, an overall greater compaction of the metallic composite can be achieved during the fusing process.

Using a suitable automated device, which will not be described in greater detail here, the metallic fibers, which are present as bulk material or in the form of mats, can be endlessly supplied to the electrodes in sections at least in one dimension. In this connection, the width of the metallic composite can be selected to be 10 mm to 2000 mm, preferably 250 mm to 1250 mm. The fibers have an average diameter of 1µm to 250µm, preferably from 30 µm to 100 µm. The metallic fibers that are used can have the same thickness, but a different length, whereby precisely by the use of metallic fibers having

different lengths, a very stable fiber structure, i.e. a fiber matrix, is formed during the compression and fusion.

A metallic composite that is produced pursuant to the inventive method can, subsequent to its manufacture, be finished and used as a sound-absorbing medium, and can be placed, for example, in a muffler system or exhaust gas pipe of a turbine. The significant advantages over heretofore known metallic composites that are produced by sintering, consists in the unlimited measurements, at least relative to one dimension, as well as the considerably more favorable manufacturing costs. Additionally, due to the possibility of the capacitor pulse fusing process, the thickness of the metallic composites can be influenced without requiring a further finishing step, such as rolling. There also results in this way an additional savings in cost, which is also advantageous relative to the conventional process. A further advantage is that the metallic composite produced pursuant to the inventive method can be further processed in subsequent processing steps. Thus, for example, it is possible via plastic shaping or molding, for example by deep drawing, to also transform the metallic composite produced pursuant to the method to geometrically complex structures. Thus, for example, spherical shaped bodies can also be formed. Since the metallic composite produced pursuant to the

inventive method is resistant to heat, it is particularly suitable as sound dampening in combustion turbines. The inventively produced metallic composite is also suitable as a gas burner insert that advantageously enables a homogeneous combustion on the entire surface of the burner.

To prevent oxidation during the fusing process, it is possible pursuant to a further feature of the invention to carry out the method in inert gas. Suitable inert gases are, for example, argon, helium and the like.

Pursuant to a further feature of the invention, the two flat sides of the metallic composite are respectively fused with a wire mesh as a cover layer. The arrangement of such wire meshes is advantageous to the extent that the method can to a large extent be carried out independently of the length and diameter of the fibers used, which can lead to ends of individual fibers extending out of the metallic composites. To counteract this circumstance, both sides of the fiber composite are fused with a wire mesh as a cover layer. In this connection, a fusing of the wire can advantageously be carried out at the same time as the fusing of the metallic fibers, so that no additional step is required as a consequence of the fusing of the cover layers.

With respect to the sound-dampening panel, to realize the aforementioned object a sound-dampening panel is proposed that is formed of a metallic fiber fleece, the metallic fibers of which are fused together, that is disposed between two cover layers.

In contrast to conventional porous metallic fiber fleeces, the individual metallic fibers of the inventive sound-dampening panel are not connected with one another in a material-flowing manner by sintering, but rather by fusing or welding. This permits not only a relatively economical manufacture of the sound-dampening panels, but it is also possible to continuously produce the sound-dampening panels, at least with respect to one geometrical dimension, so that a quasi endless metallic fiber fleece can be produced. For the further use of the metallic fiber fleece, it is then finished to length as required.

Pursuant to a further proposal of the invention, a metallic fiber fleece is fused on both of its opposite flat sides with a cover layer, which is preferably formed of wire mesh. In this way, there results an on the whole sandwiched construction having two cover layers that comprise wire mesh and between which the metallic fiber fleece is disposed.

The inventive sound-dampening panel is advantageously inherently stable, yet nevertheless permits a further processing in a subsequent processing step. Thus, for example, it is possible to further form the inventive sound-dampening panels into spherical bodies by plastic shaping, for example by deep drawing. This was not possible up to now with conventional sound-dampening panels produced by sintering, so that the inventive sound-dampening panel provides new possibilities, even for the further processing.

Due to the porous structure, the inventively produced metallic composites are suitable in particular as sound-dampening panels. In contrast to the conventional sintering process, the originally present porosity of the metallic fibers that are joined together to form the later metallic composite also remains to a great extent present after a fusing of individual metallic fibers, so that the inventive sound-dampening panels have a relatively greater porosity than do the sound-dampening panels that are known from the state of the art and are produced by sintering. The inventive sound-dampening panels can therefore exhibit an improved emission characteristic relative to conventional sound-dampening panels.

A further possibility of use for the inventive metallic composite is the use as a gas burner insert. An advantage in this connection is the multiple applicability due to the possible geometrical variety of shapes due, for example, to plastic shaping, the controlled and determinable expansion during thermal expansion, the low weight, as well as the guarantee of a homogeneous combustion over the entire surface of the burner. In addition, the inventive metallic composite offers a high reliability against flame rebound, corrosion protection even at higher temperatures, a high mechanical resistance to shock, as well as a low thermal inertion.

Further advantages and features of the invention are derived from the description with the aid of the following figures, which show:

Fig. 1: in a schematic illustration, the inventive method pursuant to a first step;

Fig. 2: in a schematic illustration, the inventive method pursuant to a second step; and

Fig. 3: in a schematic illustration, the inventive method pursuant to a third step.

Figures 1 to 3 show how to carry out the inventive method. In this connection, a first method step is schematically illustrated in Fig. 1, a second method step in Fig. 2, and a third step in Fig. 3.

Pursuant to the illustration of Fig. 1, in a first method step the metallic fibers 1 as non-compressed fibrous material, are overlaid on both opposite planar sides with a respective wire mesh 2. On those sides of the wire meshes 2 that respectively face away from the metallic fibers 1, a respective laminar electrode 3 is provided, both of which are respectively moved in the direction toward the metallic fibers 1 and thus bring and press together the wire meshes 2 and the metallic fibers 1 in the manner of pliers or tongs. This method step is schematically illustrated in Fig. 2.

The electrodes 3, with a pre-defined force F, are moved together, for example hydraulically, to such an extent until a defined surface load i.e. a defined pressure, is applied to the metallic fibers 1 and the wire mesh 2. At the same time as the pressing together of the metallic fibers 1 and the wire meshes 2, current is introduced into the electrodes 3 via the power lead 4. The introduction of power is inventively effected via capacitors that are not illustrated in this figure, whereby as a result of abrupt discharge of the capacitors, a short and strong current pulse of

up to 200,000 A is conveyed through the wire meshes 2 and the metallic fibers 1. As a consequence of the introduction of this current pulse, electrical resistances are formed between the individual metallic fibers, as a result of which the material at these locations is locally heated up and is welded or fused in a point-type manner with the closest fiber. To prevent oxidation during this fusing process, the entire process is carried out in an inert gas atmosphere.

Fig. 3 shows the finished metallic fiber composite, which is built up in a sandwich-like manner and, as cover layers has two wire meshes between which are disposed the metallic fibers 1, which are pressed together and fused with one another. As a consequence of the previously described fusing process, not only are the individual metallic fibers 1 fused with one another, but rather also the wire meshes 2 are fused with the metallic fibers 1, so that an overall stable, porous and sound-absorbing metallic composite results that nonetheless at the same time still enables the possibility of a further processing by, for example, deep drawing.

Reference Numeral List

1	Metallic Fibers
2	Wire Mesh
3	Electrode
4	Power Lead
F	Pressing Force